consist mostly of sulphates and carbonate of soda, with small portions of phosphate of soda, sulphate of magnesia, and potash, there being an entire absence of chloride of sodium and chlorine.

X.

ON GAS AND GAS WORKS.

BY A. K. SMITH, ESQ., C.E., F.R.S.SA., &c.

ENGINEER AND MANAGER OF THE CITY OF MELBOURNE GAS WORKS.

READ MAY 3, 1855.

Mr. Chairman and Gentlemen,—I beg to preface my remarks on Gas and Gas Works by stating that, although I have had considerable experience in the erection of gas works, the manufacture of coal gas, and its introduction to towns and houses for public and private uses, yet I have found it advisable to refer to such authorities as Dr. Fyfe, Messrs. Thompson, Faraday, Hughes, Gore, Rutter, &c., &c., regarding its early history, chemical analysis, &c., &c.; and as there are several interesting papers to be read this evening, I shall not attempt more than to give a brief outline of:—

1st. The history and nature of coal gas.

2nd. A description of the works necessary for its manufacture.

3rd. The adaption of these works to suit local circumstances.

4th and lastly. The application of gas to public and private uses.

1st. The subject of light, natural or artificial, has claims on all classes of society, for it is the duty of every person to study the sources from which health or domestic comforts spring, and to understand, in a certain degree, their application, the more so as the means of inquiry and investigation have been brought to a wonderful degree of simplicity and perfection, and every step thus gained increases the hope that in the end many of the seeming mysteries bearing directly on our comforts will be made clear to the searcher of the truth.

The present century has been aptly termed the age of mechanical inventions. Philosophy, arms, the arts, and literature, have had respectively their periods of eulogy, each in its turn has borne its sway over the minds and hearts of mankind. The advent of mechanical science came, and at last the genius of the steam-engine, the loom, and the print-press rose gradually into the ascendant; almost every branch of manufacturing industry bears witness to the wonderful effects which may be produced by the ingenuity of man through the medium of mechanical inventions, when his faculties are stimulated and sharpened by the necessity of supplying manual by machine labour. That coal gas, as at present manufactured and stored in the gas holder, does so, I propose to render evident, and to show that the simple movements of that apparatus, so far and in so many instances, ministers to our comforts, and substitutes, by its insensate obedience to mechanical laws, the combined saving of time, trouble, and expense, which are rendered necessary in the produce and distribution of all artificial light.

It would be out of place to give anything like a history of the rise and progress of gas lighting, suffice it is to say that amongst its foremost apostles figured the names of Murdock, Trevethick, Clegg, Dr. Henry, Watson (Bishop of Landaff), &c., &c.

The discovery and earliest observation of gas lighting by elastic or aeriform fluids, capable of being inflamed and of imparting light and heat, must, undoubtedly, have been of great antiquity. The most ancient writings contain notices of inflammable vapours springing from fissures and cavities in the earth. It is evident, therefore, that gas being a natural production, no such being as the inventor or discoverer of gas ever existed. Modern chemistry will have no difficulty in showing that all inflammable gases, whether arising naturally from rocks, or produced artificially by combustion or otherwise, are composed of very simple elements, and all present a remarkable analogy to the common carburetted hydrogen, which is the gas chiefly burnt in our street lamps and houses of the present day.

Inflammable gas may truly be said to be as old as the creation of organic matter, for whatever animal or vegetable substances have existed by the immutable laws of nature, they have been subject to decomposition; and whatever decomposition has taken place, a variety of gases have been produced, some of them inflammable, and others not so. Whether the decomposition be that caused by the slow action of decay, or that more rapid process by the application of sensible heat, the effect is the same; the gases are equally produced in the two cases.

Gas may be with more truth called a natural production than steam, although the latter has existed from the first creation of water, and in its palpable state, as proceeding from boiling water, must have been observed in all ages. The discoveries of man, with respect to gas and steam, ought rather to be called applications; they are conquests over elements, the subjugation of great powers in nature to his use and convenience. So it is with all great inventions in which we find one power of nature after another chained, confined, bound down, stored, and then let loose when required; and made to work machines and to propel ships across the ocean, to supply the place of human labour itself in a thousand varieties of ways; nay, to pass far beyond the bounds of human labour, and effect, by a single effort, that which the manual strength of the whole world would scarcely accomplish. If such astonishing applications of steam and gas had been made in the days of ancient Greece, what magnificent, all expressive, world astounding, names would have been found to convey their meaning, instead of such contemptible little monosyllables as gas and steam; one might have heard of the spirit of coal and the spirit of water, with some superlative adjective to stamp the vast importance of each. In such an age these wonderful conquests would have thrown all meaner efforts into the shade; for them alone poetry would have strung her harp, and the grandest epic productions of genius might have commemorated the victory of man over the inanimate matter of nature, instead of dedicating her loftiest songs to that curse of all ages and nations—the art of war.

The avidity with which the early nations seized on all natural phenomena, and all exhibitions of natural powers, is evident from the great veneration paid to the burning flames which issued forth from the fissures and cavities in the earth, where lakes of naphtha existed, or in the neighbourhood of coal districts. Some of the earliest nations have considered fire a type of divinity; and we can scarcely wonder at the feelings of veneration and superstition occasioned by mysterious outbursts of flame, whose origin appeared utterly incomprehensible. Hence superstition erected her altars over such flames and claimed the interference of the gods to sustain the perpetual miracle, but all that had been observed with reference to the inflammable vapours of ancient times was very far indeed from approaching to anything like a useful purpose. Far from leading to any attempt to collect any of these vapours, their very nature and composition were unknown, and the most mistaken ideas prevailed as to their real elements. It was not until modern chemistry had exploded volumes of ancient dogmas, had traced the so-called elements to their simplest forms, and had taught us the law according to which the elements are combined in order to constitute all forms of matter. It was not till then that it began to be seen that the inflammable matter of coal, wood, oils, and other fatty substances, was analogous with the marsh gas, which arises in bubbles from the decomposition of vegetables under water; that it was of the same nature as the fatal "will o' the wisp," which on the wild moor or bog has lighted many a weary and benighted traveller to destruction; finally, that it was nearly the same as that which arises from the decomposition of water however produced; and that, in fact, one of the constituents of water, the greatest antagonist and extinguisher of flame, was itself the most inflammable substance in nature, namely, hydrogen gas; while oxygen, the other element of water, is the greatest known supporter of combustion.

All organic bodies, that is to say, all bodies derived either from the vegetable or animal kingdoms, will yield gas when decomposition takes place. When such decomposition is effected by means of heating organic matter in close vessels, the gas may be collected, and when confined so as to be allowed to issue in a small jet only, from a minute orifice, the jet may be ignited and made to burn so as to give out light, and at the same time heat sufficient to inflame other portions of gas as they issue forth, and so keep up the continuity of flame.

The gases so derived are named after the chief constituents of organic bodies; thus we have

Hydrogen gas.
Oxygen gas.
Nitrogen gas.
Carbonic acid gas.

Named from the elements hydrogen, oxygen, nitrogen, and carbon, which constitute the principal parts of all organic matter. We have also gases named after a combination of these elements either with each other or with foreign bodies, frequently with organic matters, as

Carburetted hydrogen gas.
Sulphuretted hydrogen gas.
Carbonic oxide gas.

These names are so expressive that it is scarcely necessary to explain that carburetted hydrogen is a compound of the vapour of carbon with hydrogen, that sulphuretted hydrogen is a similar compound of the vapour of sulphur with hydrogen, that carbonic oxide is the vapour of carbon in combination with oxygen, &c., &c.

Coal and other bodies capable of yielding gas by distillation are composed chiefly of oxygen, carbon, and hydrogen.

When the heat reaches a certain point the combination of their elements is destroyed, and they enter into new combinations, the principal of which are the various gases arising from distillation. Thus, when one volume of oxygen enters into combination with one volume of carbon, carbonic oxide is formed; and when another volume of oxygen is added, acid gas is produced, called carbonic acid gas. Again, at one part of the process, nearly pure hydrogen is liberated, another portion of gas is formed by carbon, combining in the proportion of one volume of carbon to two volumes of hydrogen; and lastly, olifiant gas is the product of equal volumes of carbon and hydrogen entering into combination.

In all the contrivances which have been used for the production of gas from fatty matters, either in lamps or in the form of candles, the various component parts of gas, as the carbon and hydrogen, are actually vapourized and put into the form of gas before their combustion takes place. In this point of view, every wick burning in any kind of lamp or candle, is, in fact, a small laboratory for the production of gas, which is burnt or consumed at the instant of production.

It was reserved for the chemistry of our own days to point out this analogy, as it was reserved for the practical skill of engineers and mechanics to bring to perfection the means of producing this gas on a large scale, of storing it for consumption, and then sending it forth whenever required into our streets and houses, to communicate light, and enable mankind to pursue their useful and laborious vocations when darkness shrouds the earth, as well as in the light of day.

A beautiful action takes place in the combustion of an ordinary lamp or candle, in which the wick, surrounded by flame, represents a series of capillary tubes, to convey the melted matter in the form of gas into the flame. This action will be very apparent to any one who will watch the process of combustion in an ordinary wax or tallow candle. First he will perceive a cup of melted matter around the wicks, in which a great number of small globules are seen constantly in progress towards the wick; many of these globules are also seen standing on the wick, studding it all over like sparkling diamonds. Let us consider what the globules contain. They are filled with the inflammable gas produced by the heat applied to the melted wax or tallow; but fortunately for the success of this method of burning these globules do not break and set free the gas until they come in close contact with the flame, when the heat becomes so great that the expansion of the gas causes each little globule to break, and add its contents to the already existing flame.

How admirable is this provision, how exquisitely constituted are the properties of nature, to cause this beautiful result. In every common candle we behold an apparatus of refined ingenuity, in which gas is being inclosed in little microscopic pellicles, which are floated to the base of the wick; there hundreds of these little globules are seen ascending the wick, while hundreds of others are every instant exploding and discharging their contents into the flame, which is thus made up by the instant combustion of gaseous matter, at the moment when it leaves the liquid form, through the medium of this intermediate stage.

It is obvious, if the gas were to be actually formed at the surface of the small cup of melted matter already spoken of, the surface being usually half an inch below the nearest part of the flame, that the gas would immediately diffuse itself through the air, and combustion would not take place. It is only through the property which the gas possesses, of taking an intermediate form, and not finally assuming its gaseous condition till it reaches the flame, that the effect of continued combustion is preserved.

Before proceeding to consider the various products produced by the distillation of coal, as practised in gas manufacture, it may be useful to glance at the origin of the word gas. The word is very slightly altered from a German monosyllable of the same sound, signifying the ebullitions which attend the escape of aeriform fluids from substances in a state of effervescence.

The gaseous products arising from the distillation of coal may be divided into three classes. 1st. Those which are valuable for purposes of illumination, as the olefiant gas and the hydro-carburets, or vapours of volatile oil. 2nd. Those which burn with a blueish flame, and give out very little light. These are simply hydrogen gas, carburetted hydrogen, and carbonic oxide. 3rd. The injurious products that require to be separated by purification, not only on account of the evil effects arising from breathing them, but also on account of the injury to colours, &c., &c. These are carbonic acid, ammoniacal gases, sulphuretted hydrogen, and sulphuret of carbon, cyanogis is another product of distillation, due, like ammonia, to the presence of nitrogen in the coal, and, when any alkaline matter is present, cyanates are frequently found.

Coal is the remains of vegetable matter. This fact, I dare say, you are all aware of, so I shall not enter into a description of the different stages through which coal has passed, before it presents itself to us as the ordinary mineral coal of commerce.

Suppose, for instance, we have to decompose a piece of coal. We find that it contains carbon, hydrogen, nitrogen, and oxygen, in certain proportions, combined with lime, silica, sulphur, iron, and other impurities. Our object is now to obtain, for the purpose of gas manufacture, three ingredients, namely, carburetted hydrogen for light, the compound of nitrogen for chemical purposes, and the unconsumed or uncombined carbon for the purpose of fuel. Heat is the agent by which we effect the work, and it is therefore of importance to know the best means of employing that heat so as to effect the object in view in the most speedy, economical, and satisfactory manner. In order that the required substances might be evolved in sufficient quantity, we must have a proportionate amount of heat; for, if we wanted to extend a piece of coal to 270 times its bulk, the amount of heat applied must be equivalent to the force requisite to produce such a separation and expansion of its atoms. Those atoms, it must be recollected, had no disposition in themselves to move or change, the expansion must, therefore, be effected by some external agency, and rightly applied.

In order to produce gas the coal must be expanded to 270 times its bulk, and if the amount of heat applied does anything less, then, instead of producing gas we should only produce a liquid. One word as to the nature of pure and impure gas. When we make use of gas for the purpose of light we should remember that, however advantageous it might be to us to have it perfectly pure, yet we could not obtain artificial light without having a certain amount of residual products. The light from the sun leaves no products, but all artificial light must of necessity yield products, because matter, though it may undergo a change, is perfectly indestructible. Whether a certain mass of coals was consumed in a fire, or a furnace, or in a gas retort, the amount of the weight of the products would be always the same, we should still have the carbon of the coal uniting with the atmosphere, and producing carbonic acid; and the hydrogen of the coal producing water, and the nitrogen given to us in the same condition, and all the remaining products have only undergone a change as to form; therefore, it was a matter of importance to us, that in any material to be used for the purpose of giving light, its products should be as innoxious as possible. If we take coal in a perfectly crude state, and submit the gas derived from it for the purpose of illumination to a test, we shall find that it contains, first, a quantity of sulphuretted hydrogen, we shall have the carbon and oxygen uniting, giving us carbonic oxide and carbonic acid, both of which are deleterious; then the carbon and nitrogen combined, giving us cyanogen, which is the base of "Prussic acid," the well-known poison. Hydrogen and oxygen combined, giving water, hydrogen, and nitrogen, producing ammonia, oxygen and nitrogen, combined producing nitrous acid; so that these elements in their composition would give rise to (with one exception) a mass of poisonous products. But if we can get rid of the oxygen and nitrogen from our gas, we shall then have brought down our absolute poisonous products to carbon and hydrogen; and these, in the process of combustion, uniting with the oxygen of the atmosphere, would give us carbonic acid gas. Sulphur, in a state of combustion, being injurious to health, you will readily understand the necessity of removing every trace of it which the gas may contain. Doubtless, many of you may have heard of, and some unfortunately experienced, the effects of bad and impure gas, as in the eyes also on goods in linendrapers' establishments, book-bindings, picture-frames, &c., &c.

A case of this kind lately occurred at Blackheath. There a gentleman had in a room, about twelve feet square, a three-light chandelier, there was no ventilation. This gentleman was constantly complaining of a headache; his medical adviser told him the gas was not good. On complaining to the company which supplied it, he was informed that he had too much light in proportion to the current of air—that, in fact, he had a quantity equal to twenty-six penny candles, and that what he wanted was ventilation. He had a ventilater placed in the window, and the result was that the headache left him, and the gas was found satisfactory. If the public do not take the ordinary means of preventing danger or inconvenience, it will not be surprising if they feel annoyed. I throw out the hint because I know that gas must be far more extensively used than at present,—gas must eventually become the light of the masses—it is so in Scotland; and until it is so more in England and other parts of the world, it will not have accomplished its mission.

Secondly—In commencing to give a description of the works and apparatus necessary for the manufacture of gas, I shall advert, in order to be better understood, to those which will be erected at Melbourne. Some three or four years ago it was thought necessary to have a part of the public streets, trade premises, and houses of Melbourne lighted with gas. A public meeting was held and a company formed. A piece of ground for a site was purchased in the lower part of the city about 95-100th of an acre. The discovery of gold immediately after took place, and the works were for a time abandoned, or, at least, proceeded but slowly. The immense increase of the population of Melbourne in the years 1852 and 1853-4 rendered it absolutely necessary that the works should be erected on a larger scale, in order to keep pace with the rapid increase of Melbourne, which, from a town of 20,000 inhabitants in 1851, rose in eighteen months to 70,000; an increase of population, for a town of the same size, unparalleled in the annals of the world. It was determined that the company should have their manufacturing apparatus for the works from Britain, owing to the advance in price of labour in the Australian market. The propriety of at once obtaining a large site some distance from the town was apparent; accordingly suggestions were sent out from Britain, accompanied with satisfactory reasons for such advice. The promoters of the scheme here made application to the Government for a larger site, and eventually obtained a grant of five acres for twenty-one years; such site was well chosen in reference to economising the carriage of raw material used in the manufacture of gas, but otherwise ill adapted for the erection of buildings, &c., &c., owing to the difficulty and expense of obtaining foundations for the same, and in taking precautionary measures against flooding by the river Yarra. The low level of the site and the difficulties to contend with will appear more manifest, when I mention that twelve months ago, the surface of the ground at the south end of the works and upon part of which the present retort-house now stands was below the low water level of the Bay, and consequently covered by each side to a varying depth of from two to four feet at high water.

Before the erection of the works, it is necessary to have some definite information as a guide regarding the size they ought to be, in order that the capabilities for production may equal the demand for consumption; this is generally done by taking a list of the trade premises, private and public houses, churches, chapels, and street lights, &c., &c.; then, according to local circumstances, leaving a large or small margin in favour of the works. In other words, if a city or town has little staple manufacture, such as York, Canterbury, Bath, Exeter, Rome, &c., &c., then the works are generally made just of sufficient size, and the pipes running along the streets of just sufficient calibre to supply the existing wants of the community. And on the other hand, if the town or city has an extensive trade in commerce or manufactures, it is obviously better to construct the works, leaving a wide margin for extension, in such places as London, Newcastle, Glasgow, Birmingham, New York, San Francisco, Melbourne, &c.

To proceed with our illustration, the Melbourne gas works, it is determined to construct them of the following sizes and capabilities:—there are to be 120 retorts, each retort to produce, when working, 4500 feet of gas per day, that is—it will carbonize 10 cwt. of Newcastle coal, which produces on an average 9000 feet of gas per ton. We therefore multiply the 4500 by 120, and find that the total quantity of gas produced by the whole number will be 540,000 cubic feet. This quantity, when consumed at the rate of 5 feet per hour, will afford a light equal to that derived from 1,512,000 sperm candles, consuming at the rate of 120 grains per hour. I find that the total illuminating power of the gas, obtained from sixty tons of average coal, is equal to that obtained from 10 tons 16 cwt. 1 qr. 20 lbs. of sperm candles, and the relative cost of the same at the present market price of 2s. 6d. per pound; and say gas, as charged in the city of Springfield, United States, at 6 dollars per 1000 cubic feet; it is 7 dollars or 29s. 2d. per 1000 in Augusta, United States, stands thus:—

24,240 lbs. sperm candles, at 2s. 6d. ...	£3030
540,000 feet of gas, at 25s.	675
	£2355

or gas has the advantage of being nearly four and a half times cheaper than sperm candles, giving equal amounts of light.

Having now stated to you the capabilities for making gas, as far as quantity is concerned, I will now endeavour to show how the operation is carried on.

Let us take one retort, which I must beg you to understand is a cast iron or clay vessel of about nine feet in length and fourteen inches in diameter, open at one end. This retort is fixed above a furnace, and simply shielded from the intense heat of the fire by thin slabs of fire brick; this is necessary in order that the iron retorts may not be melted. Suppose the fire underneath to be kindled, it is gradually fed by coal or coke for two or three days, care been taken not to get the heat up too suddenly until the colour of the heated retort above presents the appearance of a bright cherry red; the retort is completely enveloped in brick work, with the exception of the mouth piece, spy holes are left in the front in order that the fireman may look in from time to time and examine the colour. As soon as it assumes the colour above mentioned, a charge of coals varying in weight from 150 to 250 lbs. are expeditiously thrown into the retort, and the open end is immediately covered over by a door which is luted with clay or lime mixed up into a paste-like consistency, so as to effectually prevent the gas escaping from the mouth of the retort. The closing of the mouth also effects another object, viz., the exclusion of the atmosphere, without which no combustion can take place.

The coals now fastened securely within the retort are immediately subjected to the heat of the red hot retort, and the smoke or gas in its first stage commences to rise in the ascension pipes, towards the hydraulic main, in which their ends dip a few inches below the level of the water. The hydraulic main being a cast iron cistern half full of water, in which the gas, as it forces its way through, deposits the major part of its ammonia and tar; the gas partially purified immediately ascends through the top of the hydraulic main, and is forced away by the pressure of the gas generating in the retort below, in conjunction with its own specific gravity, into what is called the condensers, which are a series of upright pipes, in which the gas ascends and descends, thereby cooling and condensing. Each time the pipe reaches the bottom of the cistern it also dips into water, and so washes and purifies the gas still more, while its condensation causes it to precipitate some of the impurities still left after passing the hydraulic main. The gas, after being so washed and cooled, has deposited all the tar and most of the ammonia, which was held in suspension, but it still possesses further impurities, namely, sulphur and sulphuretted hydrogen, in order to get rid of which it has to pass through the dry and wet lime purifiers. These are vessels containing a solution of lime in the one case, and moist lime in the other. The lime, having a strong affinity for sulphur, the gas, in coming into active contact with it is robbed of this, its last impurity, and then passes away to the metre, to measure its quantity, before passing into the gas holder: I say measure it—as it passes into a vessel divided into several compartments, and half immersed in water, in passing through which it causes the cylinder to revolve, and thereby gives motion to a piece of mechanism, which accurately registers any quantity passing through it, from one foot to one hundred million feet. After leaving the gas metre, or station metre, as it is called in contradistinction to the other metres used by the consumers, the gas passes away to the gas holder; this is the storehouse in which it is kept as it is made during the day, ready for the night consumption. Such storehouse is necessary for this reason, that as the gas is made at all hours, and the demand only occurs for about an average of five hours, it is therefore necessary to store that quantity made during the nineteen hours of the day. At Melbourne, the gas tank will be a vessel of cast iron, twenty-one feet deep by eighty-one in diameter, and possessing storage room for about three thousand three hundred tons of water, with which it will be filled; the gas holder floats in the water, and contains above one hundred thousand feet of gas when full. We have now traced its mode of manufacture from the retort where the coal is carbonized and the gas generated, until it passes the hydraulic main, there leaving a deposit of tar and ammoniacal liquor, from thence to the condensers, where it is cooled and further robbed of its impurities; from thence again to the wet and dry lime purifiers, in which any quantity of sulphur it may contain is abstracted; then it passes away from these to the station metre, to register the quantity made; and lastly, to the gas-holder or store-room, in readiness for use. Before leaving this part of the subject, I may mention that there are three things of importance in the manufacture of gas, to each of which especial attention must be paid—namely, the quantity, quality, and cost. Gas, of course, is manufactured by a company, for a two-fold object—to supply a great public want, and to afford a fair return of interest for moneys expended, or profit under good guidance to the producers. In order that it may do so, attention must be paid first to its quality, seeing that it contains no impurities; secondly, to the quantity produced from each ton of coals, that any waste by careless workmen may be checked; and thirdly, to its cost in production, that the company may be remunerated for their outlay.

The qualities of gas are not a mere matter of opinion, but, on the contrary, are based upon scientific foundations, and by the aid of chemistry are rendered evident to the senses. In order to detect the presence of sulphuretted hydrogen in the gas, a piece of common writing paper is moistened by a solution of acetate of lead—perhaps better known to you as sugar of lead—this held over a jet of gas will indicate the presence of sulphuretted hydrogen by turning black. The test for ammonia, which is an alkali, is indicated in a similar manner by either yellow turmeric, or litmus paper, first reddened by vinegar or any other weak acid. If the gas contains ammonia it restores the turmeric and litmus papers to their original yellow and blue colours; if it is free from that impurity the red colour of the changed paper remains unaffected. Again, in like manner, the presence of carbonic acid gas or any combination of sulphuric acid is determined by the blue tincture of litmus paper being changed into red.

By these means gas, in each stage of its manufacture, may be tested, and the papers used by the foreman are daily filed, for the inspection and approval of the engineer and manager, who preserves the same as a record of what has been done on that particular day. Next comes the quantity from each ton of coals. This is easily determined by the aid of the station metre, in this way: We will suppose that sixty retorts are at work, containing each exactly two cwt., or six tons in all, and that the station metre indicates 1,500,000 feet of gas; if, after the duration of six hours, we find that the retorts have ceased working, and that the index of the station metre is at 1,554,800, we then subtract the less from the greater, which leaves us 54,800 feet from six tons, or a little over 9,000 feet per ton. But this quantity depends entirely upon the quality of the coal used, some specimens giving as low as 6,500 feet per ton, others as many as 15,000 feet.

Next in order comes the cost, an important item to the company, next to the quality. I say next to the quality; for if they do not manufacture a good article, no one will purchase.

The cost of the gas is determined in this manner:—Take the last instance of 54,800 feet from six tons of Scotch cannel and English gas coal. As these coals will come from the British isles the cost will be say, delivered, £6 per ton; therefore, six tons costs £36; to which add cost of coal for carbonizing, workmen's wages, officers' salaries, a proportional share of the interest of the capital invested, and an allowance for wear and tear of retorts, and a contingent fund, at the same time giving credit for the residuary products from the distillation of the coal, such as the coke and coal tar, and the salts of ammonia, &c., &c. After subtracting their value, (which is simply what they will sell for,) from the above, it will leave, when divided by fifty-four, the selling price of 1,000 feet of gas.

Having now ascertained the cost per 1,000 feet to the consumer, we now come, in the third place, to the mode of distribution to the various localities where required. One or more large pipes are laid down from the gas-holder, along the principal approaches to towns or cities, or in the main streets thereof. The size of the main pipe laid down from the Melbourne works along Flinders-street is twenty-four inches in internal diameter, and will discharge 160,000 feet per hour, thus leaving a wide margin for the future, and, I may say, certain extension of Melbourne. Here I may at once settle a question that has been discussed pretty freely, as to whether the pipes are large enough for even the present city and suburbs, by stating that the main here described is of sufficient size to discharge, under a moderate pressure, twice as much gas as would supply the present cities and towns of Melbourne, Sydney, Adelaide, and Geelong; being five and three-fourths times as large as those employed to light the city of Amsterdam, with a population of 202,000, and nine times as large as those in Sydney. As soon as this pipe passes the entrance to King-street, a branch pipe, suitable in size for the wants of that street, always bearing in mind the chances of its extension, is laid down, and from which the west end of the city and Hotham Ward will eventually be supplied; and so on with all the other streets and suburbs of the city. When a street intersects or opens upon a lane, small branch pipes are laid on, in order to supply residents there, or any public lamps that may be required. Supposing that all the streets are supplied with pipes, it is expected that the sanitary commissioners or lighting committee will at once proceed to erect a suitable number of lamps in the city and the suburbs. These lamps are placed generally in well-lighted cities at about thirty-three yards from each other, and seldom vary, unless by their doing so they can bring a lamp to the end of another street or lane, where it may diffuse its light and perform the duty of two distinct lamps, at the cost of one. The City Council intend to light the public streets and thoroughfares of Melbourne with about 2,000 lamps, 1,000 of which are intended to be fixed first at average distances of say seventy yards, leaving space for the introduction of 1,000 more subsequently, without altering those already fixed. This is a better arrangemeut than to light half the city first, and cannot fail to give satisfaction, as it provides for a general diffusion of light amongst those who are taxed to pay for it, rather than the monopoly by one part of the city at the expense of the other. The other public purposes that gas is generally applied to are the lighting of churches, chapels, &c., &c.; one of great utility, namely, that of illuminating dials of steeple and other clocks, thus allowing to be seen

> " How steals the march of time away,
> By night as well as broad noon day."

(To be continued.)

XI.

PHONETICS.

BY W. CLARSON, ESQ.

MR. CHAIRMAN AND GENTLEMEN.—The paper I have to read before you this evening is upon the phonetic repre-